Space Weather Technical Forecast

Issued on Wednesday, 25 January 2023 at 12:48 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Reducing risk of R1/R2 Radio Blackouts. Slight chance of G1/Minor Geomagnetic Storms on Day 2 (26th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours with one M4.6 flares observed at 25/1010 UTC, likely from a combination of flare activity from AR3190 and AR3192. There are currently eight numbered sunspot regions and three unnumbered sunspot group on the visible disc. AR3190 (Eki/Beta-Gamma-Delta) in the far southwest remains the largest group, with the greatest potential for significant flares. The group contains a moderately sized delta spot, attached to the large spot in the rearward portion of the group which should reach the western limb at the end of the UTC day on Day 1 (25th). AR3192 (Cai/Beta) in the far northwest remains in a state of flux, with numerous small spots, moving around the moderately sized spot in the north of the group. This group should also reach the western limb around the end of the UTC day on Day 1 (25th).

All other regions appear generally small or stable, with little significant change observed, though AR3199 remains magnetically complex with a small Delta spot likely present. The AR3197 region was responsible for some ejecta, starting around 24/1240 UTC, although no clear evidence of a CME can be detected in either LASCO or STEREO-A imagery.

There are currently numerous filaments on the solar disc, with most of these concentrated near the western solar limb in both hemispheres, which is of note as they could be triggered by the more active sunspots here should they flare appropriately. This appears to have occurred with the LDE C-flare from AR3192 starting around 24/1400 UTC, which released a moderately-large filament and associated CME, but is not Earth-directed.

No other possible Earth directed CMEs have detected in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured at L1 by ACE and DSCOVR, have been generally at slightly elevated levels around 450km/s, reducing down to background (around 380-400km/s) at times though data has been suspect periodically. The solar wind density was at mainly average to below average levels, this tending to be coincident with discontinuity between DSCOVR and ACE data. The IMF has been weak throughout, with a peak of 7.8nT at 25/1200 UTC. The north-south component of the magnetic field was weak and mainly positive though some more significant negative spells evident from around 25/0800 UTC, with a minimum of -6.8nT recorded. The phi angle was mainly positive (away from the sun) during the period. Resultant Geomagnetic activity was Quiet (0-2 Kp).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.
High energy electron flux (greater than 2 MeV) has been at Normal Background to Moderate levels. The 24-hour integrated electron fluence stayed well below the Active threshold on a roughly level trend, with 1.06e7 integrated pfu observed at 24/2359 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be generally Low, with a daily but reducing chance of becoming Moderate, as the most potent regions in the far west of the visible disc rotate off to become far-sided by the end of Day 2 (26th). New regions likely rotating over the eastern limb in the coming days however, helping to maintain a chance of M-Class flares.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast is of lower than average confidence for the period. The likelihood of any CMEs affecting Earth during the period is low. Two HSS from coronal holes are anticipated to arrive at Earth into Day 2 (26th) and Day 3/4 (27/28th). The effects from both are expected to be relatively muted overall.

Geomagnetic activity is forecast to be Quiet through much of Day 1 (25th), perhaps increasing to Unsettled late in the UTC day and likely Unsettled by early Day 2, with the risk of Active intervals and a slight chance of G1/Minor Storm conditions. Thereafter, activity reducing to mainly Quiet to Unsettled, with a very slight chance of a G1/Minor Storm interval between Days 3 and 4.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly Background levels, but with a slight chance of reaching S1 or greater through the period. This risk should begin to lower from Day 3 (27th) onwards.

Electron flux should initially remain at Normal Background to Moderate levels, as at present. The greatest likelihood of surpassing Active fluence should arrive from Day 3 following from the arrival of any coronal hole fast wind, with the effect on electrons rated as an eventual slight chance of Active fluence at peak.

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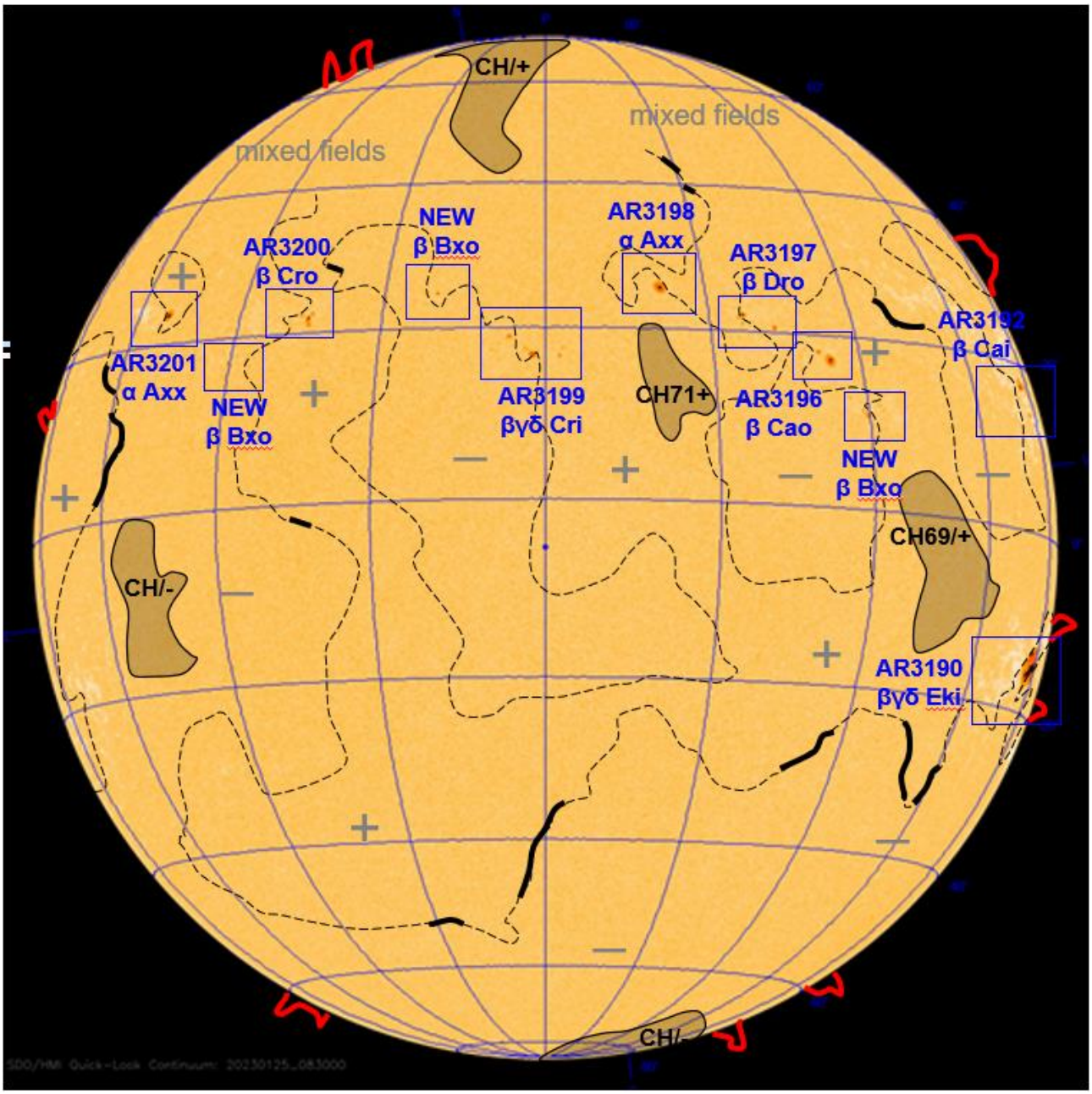
Figure 1. Solar Analysis Valid 25/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast is of lower than average confidence for the period. No Earth-directed CMEs are currently forecast. Although some faint ejecta, perhaps associated with occasional flare activity over the past couple of days, cannot completely be discounted as having some Earth directed trajectory. However, any potential impacts later in the period would be expected to be weak.

Earth is currently in a slightly elevated solar wind regime, awaiting the arrival of any CIR and likely HSS from CH69/+. This is a new feature on this rotation increasing uncertainty with respect to timings and speeds expected and as yet this feature is later than expected in arrival. At the time of writing STEREO-A perhaps seeing some heightened activity in recent hours. This likely pushes the arrival of any feature into early 26th, when solar wind speeds may increase to elevated levels. CH71/+ in the northern hemisphere, near center disc, follows between Days 3 and 4 (27th and 28th). This feature is smaller and retrogressed on the disc relative to last rotation, meaning weaker and later arrival respectively. The effects from the coronal holes are expected to be relatively muted in any case, with both being positive polarity on our approach to the negative-favoring spring equinox.

Geomagnetic activity is forecast to be Quiet through much of Day 1 (25th), perhaps increasing to Unsettled late in the UTC day and likely Unsettled by early Day 2, with the risk of Active intervals and a slight chance of G1/Minor Storm conditions. Thereafter, activity reducing to mainly Quiet to Unsettled, with a very slight chance of a G1/Minor Storm interval between Days 3 and 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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Radio Blackouts - X-Ray Flares:

While the disc remains well-populated in terms of sunspot region numbers, the relative complexity of the eastern solar hemisphere compared with the western limb is lower, and the departure of AR3190 and AR3192 into the first half of the period should serve to reduce the overall daily risk of M-class or higher flares.

Far-side soundings, returning Carrington locations of past spots and STEREO A EUVI195 imagery all hint that there may be a handful of arrivals over the eastern limb in the period, however aside from the far-sided halo CME from around 160E on the 23rd (its inferred emission position at that time), there is little evidence that any of these arriving sunspots will compensate for the departures, and the daily chances of significant flares therefore falls with time.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	40	30	30
Very Active	R3 to R5 X Class	No	5	3	1	1

Figure 2: 24hr X-ray trace from GOES-16

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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux is currently at Background levels.
While there have been examples of slight enhancements to around 1pfu in the past ten days or so at GOES16, the current disc does not appear to be particularly prone to their generation, and the largest sunspots on the disc have shown a tendency towards maturity and a general reduction in large flare activity.

All considered, there is a daily slight chance of S1 or above, with the chief contributors to this risk all now close to the western solar horizon. This risk should begin to lower as these regions rotate away onto the far side later this week.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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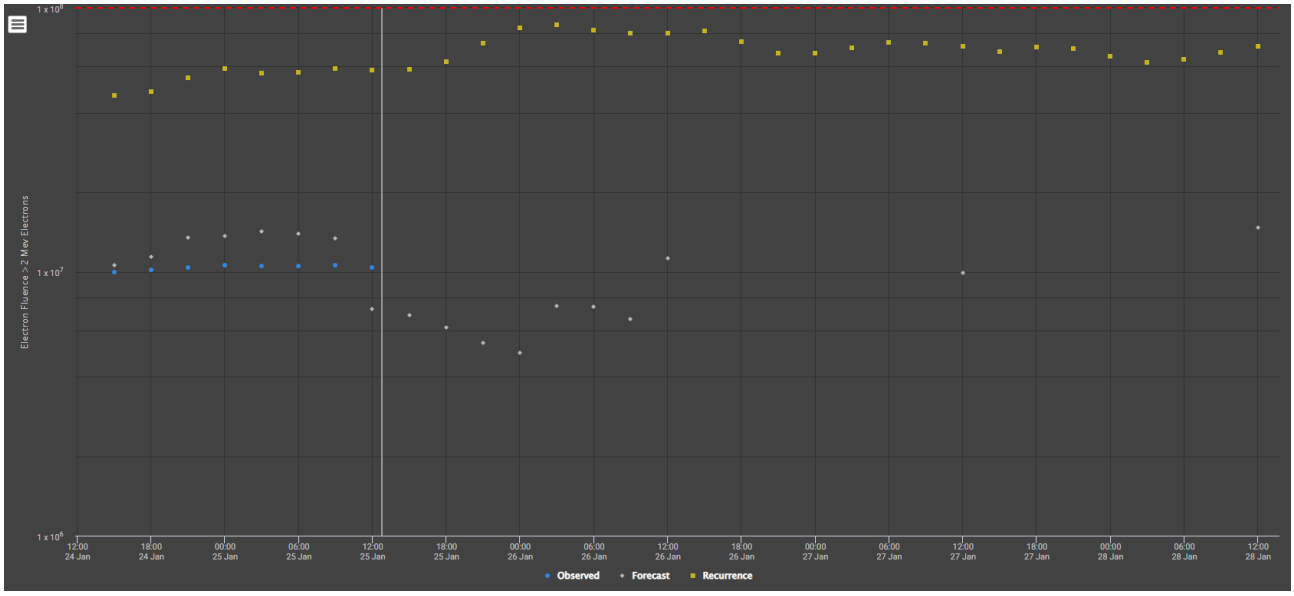
High Energy Electrons Event (≥ 2MeV):
Electron flux should initially remain at Normal Background to Moderate levels, as per its current diurnal oscillation.

The chances of geomagnetic activity before Day 2 (26th) are very low. The electron flux has not shown any willingness to rise beyond its current level even in this absence of geomagnetic activity, and the current observations probably represent a near-steady state.
Any electron response will probably arrive towards the end of the current working week between any fast winds from CH69/+ and CH71/+, however this is now judged as a low-end chance, and even this ought to be brief should it occur.

MOSWOC REFM is not considered particularly useful guidance at present given the relative dominance of non-persistent features in the forecast, however it suggests levels below Active throughout the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	15	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Latest MOSWOC REFM Model output



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